Circular Parachute

BACKGROUND OF THE INVENTION

1. Technical Field

[01.00] This invention relates generally to parachutes, and more particularly to a circular parachute.

2. Description of Related Art

[02.00] A typical circular parachute includes a canopy to which a set of suspension lines is attached. The suspension lines connect the canopy to a harness that attaches to a person, cargo, or other load. Air inflates the canopy during descent and the drag provided reduces speed.

[03.00] The canopy of a circular parachute (i.e., a round parachute) is commonly made of a circularly shaped nylon fabric (i.e., the canopy fabric). The canopy of the flat circular type has an outer perimeter that forms a circular configuration when the canopy is laid flat upon the ground. When fully inflated, the canopy usually takes the shape of a hemispherical cap, although in some cases, the cap is slightly conical and in others, slots or concentric gaps are provided in the canopy that enhance stability. A circularly shaped central opening is often provided in the canopy to form a vent at the apex of the canopy. The circularly shaped marginal edge portion of the canopy along the perimeter of the vent is sometimes referred to as the "vent band" of the canopy, while the

circularly shaped marginal edge portion of the canopy along the outer perimeter is sometimes referred to as the "skirt band."

[04.00] Suspension lines nowadays are commonly nylon too, although some use materials available under the trademarks KEVLAR and SPECTRA. They function to suspend the load from the canopy. For canopies having a vent, vent suspension lines are attached to the vent band. With the canopy descending vertically and fully inflated, the vent suspension lines converge downwardly in a vent suspension line confluence extending to a single, vertically extending, vent centerline. Main suspension lines are attached to the skirt band. With the canopy descending vertically and fully inflated, the main suspension lines converge downwardly in a main suspension line confluence extending with the vent centerline to a suspension line junction that is connected to a harness for the load.

[05.00] One recognized problem common to the canopy and the suspension lines appears as the parachute is deployed. The suspension lines unfold until they are fully stretched. Then, the canopy unfurls and begins inflating. As that occurs, sudden shocks and other large forces are produced that can cause random failures modes, including structural failures of the canopy and/or suspensions lines. Various techniques exist to help overcome this problem, but improvement remains desirable. Thus, a need exists for a better circular parachute configuration.

SUMMARY OF THE INVENTION

[06.00] This invention addresses the concerns outline above by providing a circular parachute having cascaded suspension lines. The suspension lines are cascaded in the sense that each main suspension line includes a lower segment that branches upwardly into two upper segments. That arrangement doubles the number of suspension lines connected to the skirt band of the canopy with one-half the number of lines at the suspension line junction, thereby distributing the peak opening forces more evenly along the skirt band.

[07.00] There is a reduced potential of suspension lines tensioning at different times as experienced in an asymmetrical deployment. The advantage of line cascading is realized through a reduced number of suspension lines to the attach point and a reduction in distance that one upper suspension line can tension before another if on the same lower suspension line (the length of the upper suspension line is less than the total suspension line length). Both of these contribute to the reduction of asymmetrical deployments.

[08.00] To paraphrase some of the more precise language appearing in the claims, a parachute constructed according to the invention includes a circularly shaped canopy having a skirt band and a plurality of main suspension lines connected to the skirt band. According to a major aspect of the invention, each main suspension line is cascaded in the sense that it includes a lower main suspension line segment that branches

into at least two upper main suspension line segments. In one embodiment, ten lower main suspension line segments branch into twenty upper main suspension line segments connected to the skirt band. The ten main suspension lines converge from the skirt band toward a suspension line junction.

[09.00] The circular parachute may include a vent band on the circularly shaped canopy and a plurality of cascaded vent suspension lines. In one embodiment, ten lower vent suspension segments branch into twenty upper vent suspension line segments connected to the vent band, and the ten vent suspension lines converge from the vent band toward a vent centerline that extends to the suspension line junction.

[10.00] According to another aspect of the invention, there is provided means for slowing the opening of the canopy, including a generally planar reefing device defining a plurality of openings through which the main suspension lines extend (i.e., suspension-line-receiving openings). Preferably, the reefing device includes a strip of material folded into five strip segments arranged in a five-point star configuration having five strip segment junctions uniformly spaced apart at the points of the five-point star configuration. Five eyelets secure the five strip segment junctions, each of the eyelets extending through a respective one of the strip segment junctions to form the five suspension-line-receiving openings. In one reefing device embodiment, the five strips segments are portions of a nylon strap, each strap segment measuring about seventeen inches

long, and the strap segments are secured with eyelets in the form of brass grommets.

[11.00] Thus, the invention provides a cascaded suspension line arrangement that distributes the peak opening forces for a more even load distribution by the suspension lines that reduces the peak opening forces. In addition, the cascaded suspension lines reduce the number of lines to the attachment point by fifty percent or more. Furthermore, the use of cascaded suspension lines provides the ability to integrate suspension line materials with dissimilar physical properties (primarily elongation) in the segmented suspension lines in order to thereby tailor the opening characteristics of the parachute as desired. Moreover, the use of cascaded suspension lines provides an additional force component to control the descent of the slider (i.e., the reefing device). The angle of the upper suspension line segments that initiate the descent of the slider provide the ability to control the peak opening forces at low and high speeds. The following illustrative drawings and detailed description make the foregoing and other objects, features, and advantages of the invention more apparent.

BRIEF DESCRIPTION OF THE DRAWINGS

[12.00] FIG. **1** of the drawings is a diagrammatic elevation view of a circular parachute constructed according to the invention, shown descending vertically with the canopy fully inflated;

[13.00] FIG. **2** is a diagrammatic isometric view of the circular parachute with the canopy fabric omitted in order to emphasize the skirt band, the main suspension lines, the vent band, and the vent suspension lines;

[14.00] FIG. **3** is a diagrammatic bottom view of the skirt band, the main suspension lines, the vent band, and vent suspension lines as viewed looking upwardly from the suspension line junction;

[15.00] FIG. **4** is an enlarged diagrammatic isometric view of just the vent band and the attached vent suspension lines, with the vent centerline foreshortened for illustrative reasons;

[16.00] FIG. **5** is a top plan view of a reefing device for slowing the opening of the canopy; and

[17.00] FIG. **6** is an isometric view of the reefing device showing the vent centerline strung through the central opening and the ten lower suspension lines strung through the five eyelets.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[18.00] FIGS. **1-5** of the drawings show various aspects of a circular parachute **10** constructed according to the invention. Generally, the

parachute **10** includes a circularly shaped canopy **11** and ten main suspension lines **12**. Only one of the ten main suspension lines **12** is identified with a reference numeral in FIGS. **1**, **2**, and **3** for illustrative purposes. The other nine main suspension lines are similar to the one that is identified.

[19.00] The canopy **11** is composed of a parachute grade of nylon fabric or other suitable material (i.e., the canopy fabric) that is depicted in FIG. **1** by the shaded portion of the parachute **10**. The canopy fabric is omitted from FIGS. **2**, **3**, and **4** for illustrative purposes, however, in order to emphasize the main suspension lines **12**. The main suspension lines **12** may be of nylon composition also, and they are depicted by bold lines in FIGS. **1-4**. The canopy **11** includes a known sort of circularly shaped skirt band **13** to which the main suspension lines **12** are connected in a known manner, with the main suspension lines **12** extending from the skirt band **13** to a known type of suspension line junction **14** (FIGS. **1-3**) that may in turn be connected in a known manner to a load (not shown).

[20.00] The canopy **11** and main suspension lines **12** may be similar in some respects to existing parachute components and they are sized according to the intended parachute application. As the parachute **10** descends vertically with the canopy **11** fully inflated as depicted in FIG. **1**, the canopy **11** and the main suspension lines **12** are disposed symmetrically about a vertical central axis **15**. The main suspension

lines **12** converge downwardly from the skirt band **13** toward a main suspension line confluence at the suspension line junction **14**.

[21.00] According to a major aspect of the invention, each main suspension line **12** is cascaded. It is cascaded in the sense that it includes a lower segment **12A** that branches upwardly at a junction **12B** into at least two upper segments **12C** and **12D** (FIGS. **1-3**). The two upper segments **12C** and **12D** are connected to the skirt band **13** at skirt band attachment points **16** and **17**, extending downwardly from the skirt band attachment points **16** and **17** in converging relationship to each other to the junction **12B** where they are tied to or otherwise suitably connected to the lower segment **12A**. Preferably, the skirt band attachment points **16** and **17** (and the other eighteen unidentified skirt band attachment points) are uniformly space apart along the skirt band **13** at 18-degree intervals as illustrated in FIG. **3**. The net effect of that entire arrangement of cascaded main suspension lines **12** is to provide a better force distribution with fewer lines connected to the suspension line junction **14** as stated previously.

[22.00] In addition to the foregoing features, the canopy **11** of the illustrated parachute **10** includes a vent **20** (a circular central opening) that is identified in FIGS. **1** and **2** by an arrow **20**. The vent **20** is defined by a circularly shaped vent band **21** portion of the canopy **11** that is identified in FIGS. **2**, **3**, and **4**, with FIG. **4** being an enlarged diagrammatic view of just the vent band aspects of the parachute **10**.

[23.00] A plurality of ten vent suspension lines **22** are connected to the vent band **21**, only one of the ten vent suspension lines **22** being identified with a reference numeral in FIGS. **1**, **2**, **3**, and **4** for illustrative purposes. The other nine vent suspension lines are similar to the one that is identified, converging downwardly from the vent band **21** toward a vent suspension line confluence at a vent suspension line junction **23** that is connected to a vent centerline **24**. The vent suspension lines **22** are tied to or otherwise suitably connected to the vent centerline **24** at the junction **23** (e.g., finger-locked loops), and the vent centerline **24** extends downwardly from there to the suspension line junction **14**.

[24.00] Similar to the main suspension lines **12**, each vent suspension line **22** is cascaded in the sense that it includes a lower vent suspension line segment **22A** that branches upwardly at a vent suspension line junction **22B** into at least two upper vent suspension line segments **22C** and **22D** (FIGS. **4**). The two upper vent suspension line segments **22C** and **22D** are connected to the vent band **13** at vent band attachment points **24** and **25**, extending downwardly from the vent band attachment points **24** and **25** in converging relationship to each other to the vent suspension line junction **22B** where they are tied to or otherwise suitably connected to the lower segment **22A**. Preferably, the vent band attachment points **24** and **25** (including the eighteen unidentified vent band attachment points) are uniformly space apart along the vent band **13** at 18-degree intervals as illustrated in FIG. **4**.

[25.00] Turning now to FIGS. **5** and **6**, they show various details of a reefing device in the form of a slider **30**. It functions as means for slowing the opening of the canopy **11**. Doing so with a reefing device is a known technique and reference may be made to U.S. Patent 4,863,119 for some related details and further information. The slider is more effective during high speed deployments and does not slow the opening too much during slow speed deployments.

[26.00] The slider **30** is a generally planar device fabricated from a strip of material (e.g., a nylon strap) that is folded into five strip segments **31**, **32**, **33**, **34**, and **35** (FIG. **5**) that are arranged in a five-pointed star configuration. Each strip segment **31-35** is preferably of uniform length and preferably in the range of about sixteen inches to about eighteen inches for the illustrated parachute **10**. The illustrated strip segments **31-35** measure about seventeen inches long and about 1.75 inches wide, although the slider **30** can be scaled according to the diameter of the parachute so that dimensioning may vary within the scope of the broader claims.

[27.00] As shown in FIG. **5**, the strip segments **31** and **32** are connected together at a strip segment junction **42** (at a fold in the nylon strap) by an eyelet in the form of a brass grommet **52** that defines a suspension-line-receiving opening **62**. The grommet **52** may, for example, have an outside diameter measuring 1.125 inches and an inside diameter measuring about 0.675 inches. Similarly, the strip segments **32** and **33** are connected together at a strip segment junction **43** by a grommet **53**

that defines an opening **63**, the strip segments **33** and **34** are connected together at a strip segment junction **44** by a grommet **54** that defines an opening **64**, the strip segments **34** and **35** are connected together at a strip segment junction **45** by a grommet **55** that defines an opening **65**, and the strip segments **35** and **31** are connected together at a strip segment junction **41** by a grommet **51** that defines an opening **61** Stitching **71**, **72**, **73**, **74**, and **75** helps secure the strip segments **31-35**.

[28.00] So constructed, the slider **30** may be easily and inexpensively fabricated, and it works well with the ten main suspension lines **12** described above for the parachute **10**. As shown in FIG. **6**, each one of five pairs **81**, **82**, **83**, **84**, and **85** of the lower segments **12A** of the ten main suspension lines **12** are strung through a respective one of the grommets **51-55** (i.e., through the five suspension-line-receiving openings **61-62** defined by the grommets), and the vent centerline **24** is strung through a central opening in the slider **30** defined by the strip segments **31-35**. As the canopy **11** unfurls, the slider **30** slows the opening of the canopy **11** in a known manner, eventually moving downwardly along the main suspension lines **22** toward the suspension line junction **14** to the position shown in FIG. **6**.

[29.00] Thus, the invention provides a circular parachute having cascaded suspension lines so that the number of suspension lines connected to the skirt band of the canopy increases while the number at the suspension line junction decreases. In addition, a slider is provided

in a five-pointed star configuration can be easily and inexpensively fabricated for use with the parachute. Although an exemplary embodiment has been shown and described, one of ordinary skill in the art may make many changes, modifications, and substitutions without necessarily departing from the spirit and scope of the invention. Some parachutes (primarily personnel parachute systems), for example, have multiple attach points (usually two to four attach points on the risers on personnel parachute systems), and the invention may be applied to those type of parachutes also within the scope of the broader claims. A ten-point star slider can be constructed with two five-point stars stacked on top of one another. As parachutes increase in diameter, the number of suspension lines increases (e.g., a 100-foot diameter parachute is likely to have about one hundred suspension lines). All such variations, including various numbers of suspension lines and slider grommets, are intended to fall within the scope of the broader claims.

[30.00] What is claimed is: